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Activity Based Cost Structure Analysis of Submarine Force Readiness

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NAVAL POSTGRADUATE SCHOOL

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EMBA PROJECT REPORT

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EXECUTIVE SUMMARY

Commander, Submarine Forces (COMSUBFOR) has been directed by the Chief of Naval Operations (OPNAV) to develop a financial model that relates force readiness to budget authority given in the Navy's Ship's Operations Account (O&MN 1B1B). In order to develop this model, COMSUBFOR must identify the significant cost drivers with regard to submarine operations and the activities that influence them.

Peninsula Graduate Consultants (PGC) has completed an analysis of a total of 33 submarine years of Fleet Readiness Training Plan (FRTP) activities and the associated repair part (1B1B-SR) spending on a daily basis. We applied our analysis to the SSN-688/688i submarines of Submarine Squadrons Two (CSS-2) and Six (CSS-6) during calendar years 2005, 2006, and 2007. All financial data was computed in terms of calendar year 2007 dollars. Furthermore, we retroactively applied the current Submarine Force business rules that define in what phase a ship is operating within the FRTP structure and the criteria for a ship to transition between phases. The repair part data was obtained from the Naval Sea Systems Command Logistics Center Open Architecture Retrieval System (NSLC OARS). Each requisition with its corresponding issue quantity, date of requisition, and net cost (accounting for issue quantity and net effect of

DLR turn-in credit) was compared to each ship, by date, activity, and FRTP phase.

The following are the conclusions of Peninsula Graduate Consultants. COMSUBFOR units are not providing NSLC with accurate data. Corrective and preventive maintenance requisitions are being submitted in a manner such that we were unable to isolate corrective versus preventive maintenance in OARS. The relationship between FRTP events (activities and phases) and spending is limited. Other OPTAR spending is not maintained in a format that can be correlated to date, activities, and phases. Evaluating spending by each item's defined Mission Criticality Code (MCC) provides a focus area if maintenance must be deferred due to fiscal constraints.

The following are the recommendations of Peninsula Graduate Consultants. First, adapt a method of data entry in OARS so preventive and corrective maintenance items are isolable. Commander, Naval Surface Forces Atlantic (COMNAVSURFLANT) procedures accomplish this and can be referenced for ease of implementation. Second, conduct an analysis of spending versus startups and shutdowns. This will help to determine if cycling equipment is a significant driver of maintenance spending. Third, focus on spending versus MCC when faced with funding reductions. Some items of lesser essentiality in terms of the ship's missions and mobility may be deferrable; however, consideration must be given for the risk of a "snowball effect" resulting from numerous small items being deferred simultaneously. Finally, evaluate spending versus FRTP phase as variable on a daily basis rather than a monthly basis,

which is the current method. The Force should add a tracking mechanism (“concurrent event bar” in WEBSKED) which the Operations Department will maintain to keep an accurate history of each ship’s progression through the FRTP.

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I. INTRODUCTION AND BACKGROUND

A. INTRODUCTION

Commander, Submarine Forces (COMSUBFOR) has been directed by the Chief of Naval Operations (OPNAV) to develop a financial model that links Force readiness to funding levels in the Navy's Ship Operations Account (code 1B1B). Presently, COMSUBFOR is unable to clearly identify the cost drivers for ship level repairable and consumable coded funds (1B1B-SR, and 1B1B-SO, respectively).

B. BACKGROUND

Wartime operations have put significant pressure on the COMSUBFOR ship operations budget. OPNAV has tasked the Submarine Force with identifying the effect to deployable submarine support based on reductions to the 1B1B account. OPNAV has put forth a strategy for maintaining fleet readiness that directs the Type Commanders to certify their units ready to "surge" deploy on short notice. This directive is known as the Fleet Readiness Training Plan (FRTP). COMSUBFOR categorizes the level of a submarine's readiness in terms of four different phases: Not Ready, Ready for Tasking, Surge Ready, and Deployed. COMSUBFOR has developed the first version of a funding model that attempts to predict readiness levels based on a specific level of funding. The model has not been validated. Therefore, decision makers are not sure that the output of the funding model can accurately predict readiness levels.

C. PROJECT OBJECTIVES

Our objective is to provide COMSUBFOR relevant cost information with respect to the activities that comprise the FRTP to aid decision makers in formulating business rules that accurately reflect changes in readiness due to changes in funding. Specifically, we will attempt to answer the following questions:

1. What is the cost structure (i.e., fixed vs. variable costs, corrective vs. preventative maintenance costs, repair vs. other OPTAR costs, etc.) of the activities within the FRTP?
    a. What are the major cost drivers associated with maintaining particular readiness levels?
    b. What relationships exist between maintenance costs and specific events within the FRTP?
    c. What is the breakdown of maintenance costs associated with the various levels of mission essentiality?

D. PROJECT SCOPE

Our analysis focuses solely on expenditures from the 1B1B-SR and SO accounts for Atlantic Fleet based SSN 688 and 688(i) class submarines. We limit our sample to submarines in Squadron Two and Six, a total of 11 out of 23 east coast based submarines (48%). We limit the data set to cover calendar years 2005, 2006, and 2007. We exclude from analysis any SSNs which changed homeport for shipyard maintenance availabilities. These scope limitations reflect

the stated policy of COMSUBFOR to fully fund SSGN and SSBN operations, the limited class size of the USS SEAWOLF (SSN 21) and USS VIRGINIA (SNN 774) class submarines, and the differences in funding D level maintenance vice O and I level maintenance.

This analysis is intended to provide information and recommendations to decision makers. The recommendations will focus on the possible uses of the results of the analysis and not upon any specific case of submarine readiness.

E. METHODOLOGY

We obtained logistics and repair parts cost data from the Open Architecture Retrieval System (OARS) database maintained by the NAVSEA Logistics Center in Mechanicsburg, PA. Other OPTAR spending figures were not available in the Budgeted OPTAR Report (BOR) format from the COMSUBFOR comptroller's office as expected. This will be discussed further in the conclusions and recommendations section of this report. COMSUBFOR daily historical schedule data for each submarine, maintained by N3, was used for mapping the events of the submarines in the data set.

Using a modified version of the Surface Warfare Enterprise Cost Analysis Tool (SWECAT), developed by COMNAVSURFLANT, we performed an activity based costing analysis on the entire FRTP. Additionally, we analyzed each phase of readiness, and each individual activity within the FRTP (Enclosure 1 includes a glossary of the abbreviations used for these events). We broke down the cost structure of each of these events with regard to ship repair parts. Within the ship repair parts category, we were unable to segregate preventative

and corrective maintenance costs due to the manner in which the data was submitted to NSLC. We also identified the major maintenance cost drivers by Equipment Identification Code (EIC) and Mission Criticality Code (MCC). During our research stage, we sought expert advice from staff officers at COMSUBFOR, COMNAVSURFLANT, and NAVSEALOGCEN.

A financial model is only as accurate as the data on which it is built. A more detailed and substantial data set yields a higher potential for predictive accuracy. Our data set included over 83,000 requisitions and their associated issues spread across a representative sample of the Second Fleet based SSNs. Three calendar years of data for 11 operational submarines yielded over 12,000 submarine days, including ten deployments.

Peninsula Graduate Consultants has provided this written report and power point presentation to COMSUBFOR to present our findings in a logical and useful way. This report will also be submitted to Professor Alice Crawford at the Naval Postgraduate School to satisfy the requirements for completion of the Executive Masters of Business Administration program. The data, the analysis, and the final report will not be shared with any other organization without the prior approval of COMSUBFOR.

II. RESULTS

Through our analysis we were able to evaluate spending, FRTP phase, and activities within the phases on a daily basis. Currently, COMSUBFOR is evaluating spending and the FRTP phases on a monthly basis. Analyzing costs at this level may mask true cost drivers. For instance, if a submarine spends 16 days out of a 30 day month in the Surge phase, with the other 14 days spent in the Ready for Tasking phase, it would be categorized in the Surge phase for the entire month. The costs for any components ordered during the 14 days spent in Ready for Tasking would be incorrectly counted as Surge related costs. Therefore, the spending during Surge will be biased high. Although the total cost is still being captured, misattributing it to the Surge phase will reduce the effectiveness of predictive financial modeling.

Our analysis has shown a limited relationship between the various activities within the FRTP and associated spending. This is evident by the large standard deviation of spending across the 11 surveyed units for each activity. Figure 1 provides an analysis of the mean spending and standard deviation, by hull number, of each activity in the FRTP. However, our analysis does concur with the existing model showing a steadily increasing trend in average 1B1B-SR spending as each submarine transition through the FRTP. The cause of this is not readily apparent. Two possibilities are a relationship between equipment cycling (start-ups and shut-downs) and failure rate or a relationship between total

run time since last major maintenance and failure rate. The combination of these two represents a third major possibility.

A cursory examination of WEBSKED will show that as the ships progress through the FRTP they spend, in general, a significant amount of time at sea coupled with many arrivals and under ways from port. This is particularly noticeable when operating in the six- month pre-deployment Surge category. When contrasted with Deployment, one sees a ship with long stretches of continuous, at-sea operations, limited start-up and shut-down cycling; all resulting in the lowest, average dollar per day 1B1B-SR spending. Our assessment is that 1B1B-SR costs are being driven by ship evolutions that are occurring below the level of detail provided in WEBSKED.

Other OPTAR spending (1B1B-SO) is not being reported or maintained in a format that is useful for determining cost drivers and building a predictive financial model. The Budgeted OPTAR Reports (BOR) are year-to-date summaries of total OPTAR spending broken down by squadron, ship, and code. The summarized data lacks the granularity to effectively link activities and the costs they generate. Transaction Ledgers (TLs) are transmitted by each ship on a weekly basis (as operational schedule permits) and contains an itemized list of expenditures. However, there is no field within these reports that indicate when expenditures occurred or are expected to occur. Once again, it is difficult to tie these expenditures to the specific activities the ship is performing. Without the capability to identify when costs are being generated and what is generating

them, analysis of 1B1B-SO spending can only be performed at the aggregate level and may negatively impact the accuracy of financial modeling.

During our research we discovered NAVSEA Logistics Center is not being provided with accurate data from the Submarine Force. The data in OARS should be distinguishable between corrective and preventive maintenance repair part requisitions. Currently the Force is submitting repair part requisitions identically for both types of maintenance. This provides an artificial demand signal to NSLC in terms of equipment failure rates.

The inability to separate the two types of maintenance hinders the Force from being able to determine what their fixed versus variable costs are. Preventive maintenance is a fixed cost. When a piece of equipment is purchased and installed, the Force does so knowing the expected maintenance costs on that piece of equipment. This lifecycle preventative maintenance cost plus the purchase price should be viewed as overhead. All other maintenance expenditures for that piece of equipment should be viewed as variable costs. If data is submitted to NSLC correctly, the Force should be able to easily verify that actual overhead matches expected overhead.

The source of repair part requisition data used by PGC allows for a more detailed analysis than that of the existing model. We gathered our data from OARS as compared to the STARS database used currently by COMSUBFOR. The data in OARS allowed us to isolate a component by its requisition date. Assuming the requisition is made shortly after the deficiency is noted; the

requisition date will very closely reflect the date of equipment failure. STARS, on the other hand, reports the date that funds were obligated. Several factors make this date time late. For instance, there may be long delays in repair part issues date due to backorders in the supply system. This allows for the possibility that the ship has transitioned between two or more FRTP phases before a repair part is finally issued and the obligation is recorded. Therefore, this method of accounting masks the true costs of phases and activities and limits its usefulness in building a financial model.

Nearly 90 percent of 1B1B-SR spending, as shown in Figure 2 is obligated to items that have a clearly defined Mission Criticality Code (MCC). Each component is assigned a MCC by the system engineers at NAVSEA. This code relates the significance of failure of nearly every component in a system to system performance overall. The failure of a component with MCC-1 has little impact on system performance and negligible impact on the ship's primary and secondary missions. An item with MCC-4 results in loss of ship's mobility or a complete loss of primary mission capability. An item like this is likely to result in the generation of a Category 3 Casualty Report (CAT-3 CASREP) (Enclosure 2 contains the full definition of the MCC's as defined by NAVSEA).

Knowledge of a component's MCC, and therefore the impact of the failure of that component on the system and ship's mission, as well as the knowledge of the percentage of spending absorbed by the various MCC's are tremendously important. This will allow the Force to make decisions, if necessary when funding is limited, about deferring maintenance on items of

lesser significance. This is also reflected in Figure 2 which demonstrates the results of our study of MCC versus percentage of total 1B1B-SR spending. Of note, 20% of 1B1B-SR is spent on components whose failures cause only a minor impact on the ship. Additionally, there are items with “blank” MCC’s that account for 10% of spending. These components may provide the Force with an easy focus area for a possible cost reduction of up to 30%.

The following figures, labeled Figure 1 through Figure 5, demonstrate the analysis we conducted with the data obtained from OARS and the schedules for each ship as maintained in WEBSKED.

Mean and Standard Deviation of Cost per Submarine Day by Phase and Activity (Using Mean Costs by Hull No.)

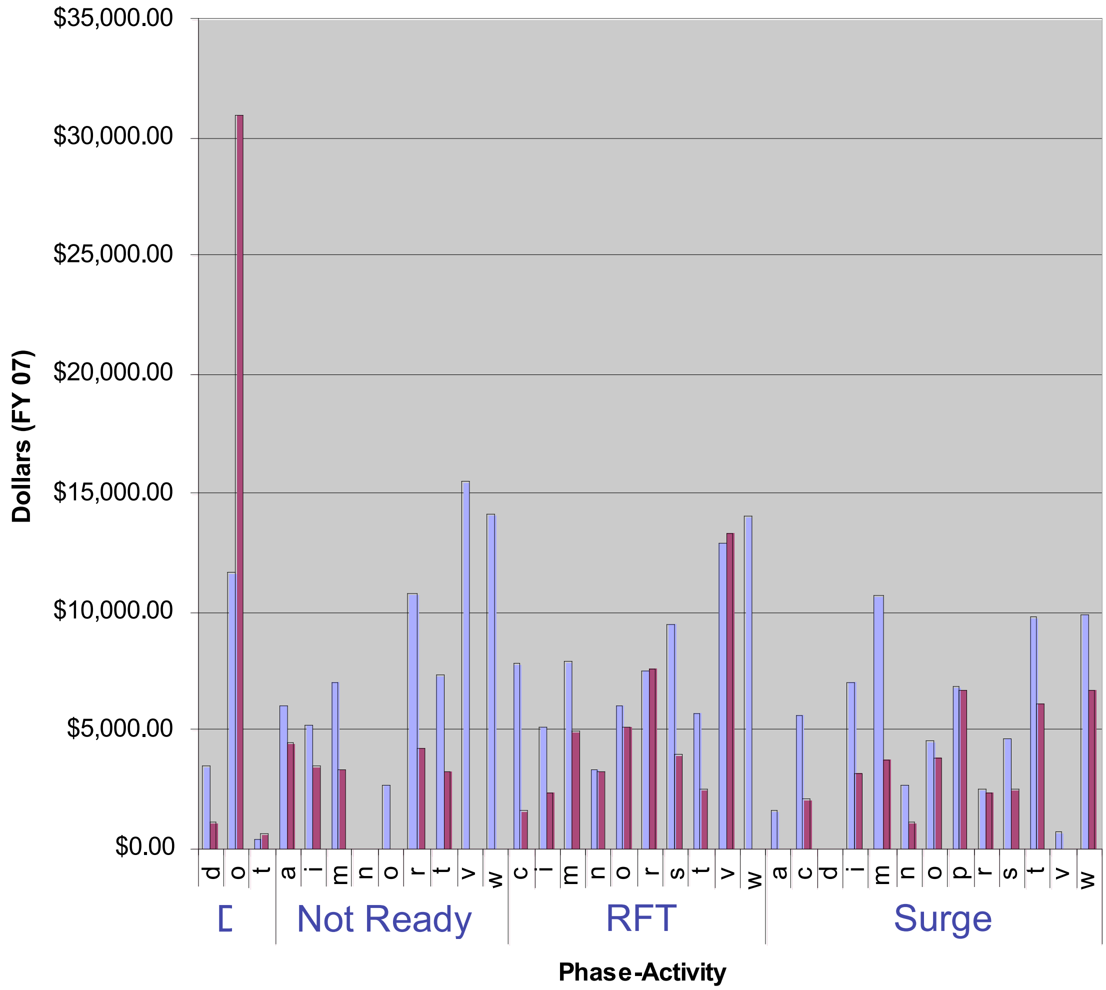

Figure 1

Figure 3 shows the mean and standard deviation of cost per submarine day, by phase and activity. This graph was generated using Microsoft Access and the data set for all 11 submarines sampled.

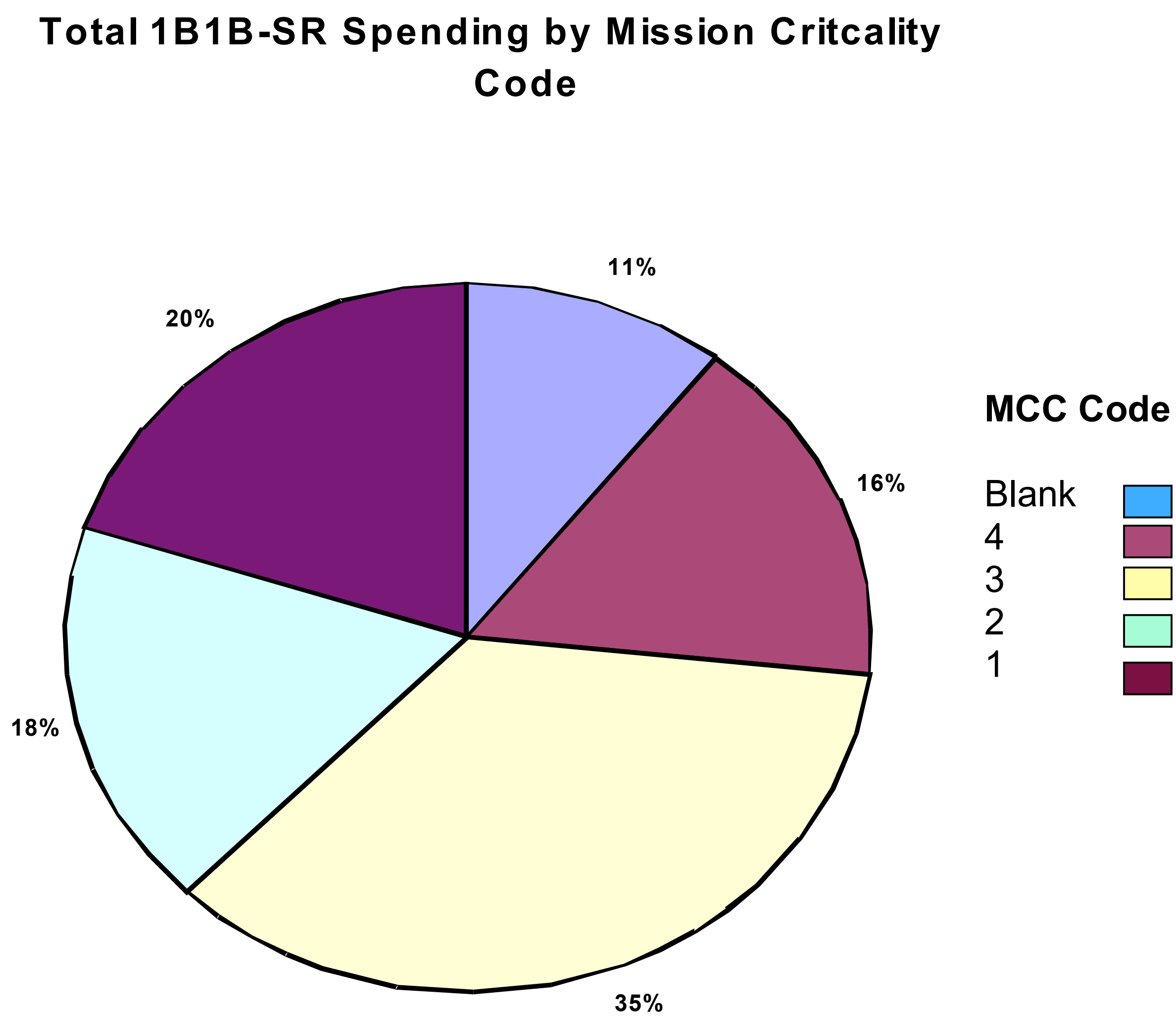

Figure 2

Figure 3 shows the percentage of total net 1B1B-SR spending based on MCC Code. This graph was generated using Microsoft Access and the data set for all 11 submarines sampled.

Top 10 EIC (All Phases and Activities)

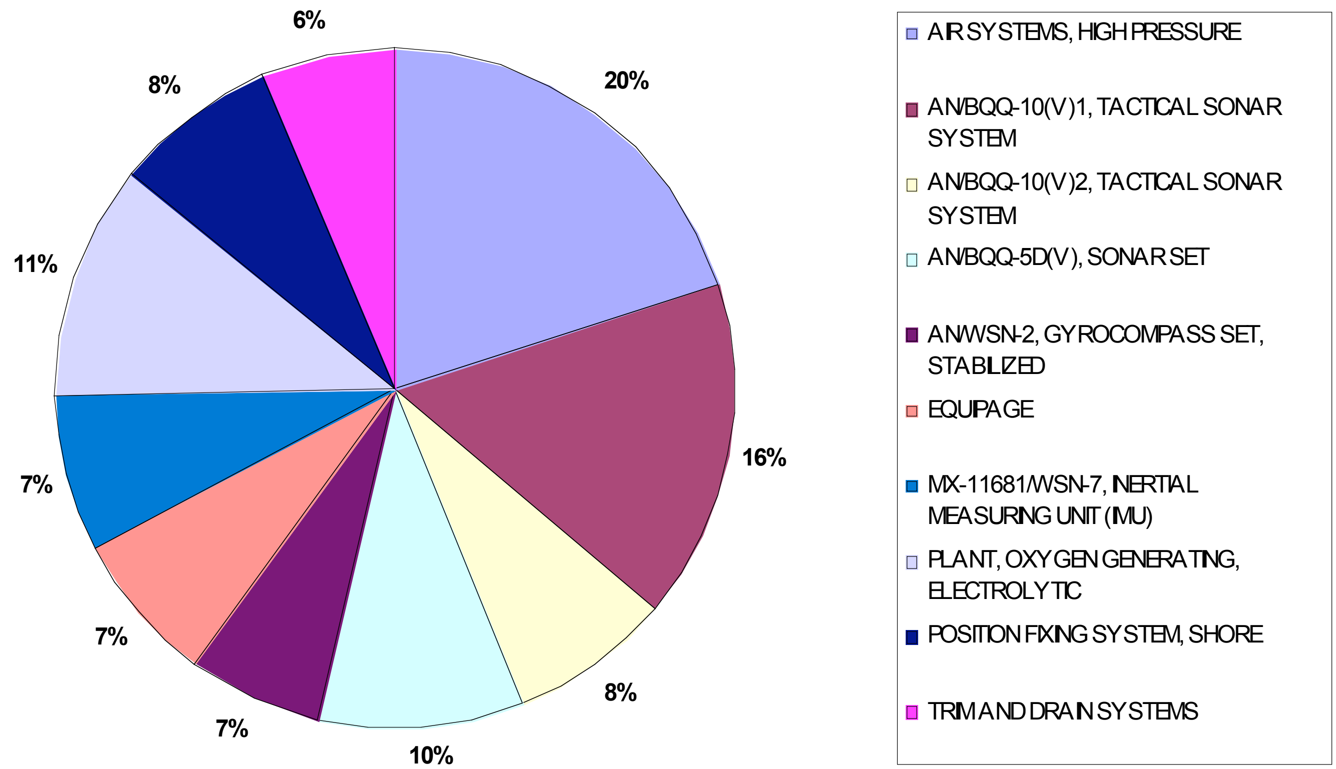

Figure 3

Figure 4 shows the 10 most common systems, in terms of total dollars spent, and the percentage of spending within those 10 that each represents. This graph was generated using Microsoft Access and the data set for all 11 submarines sampled.

Total 1B1B-SR Spending by FRTP Phase

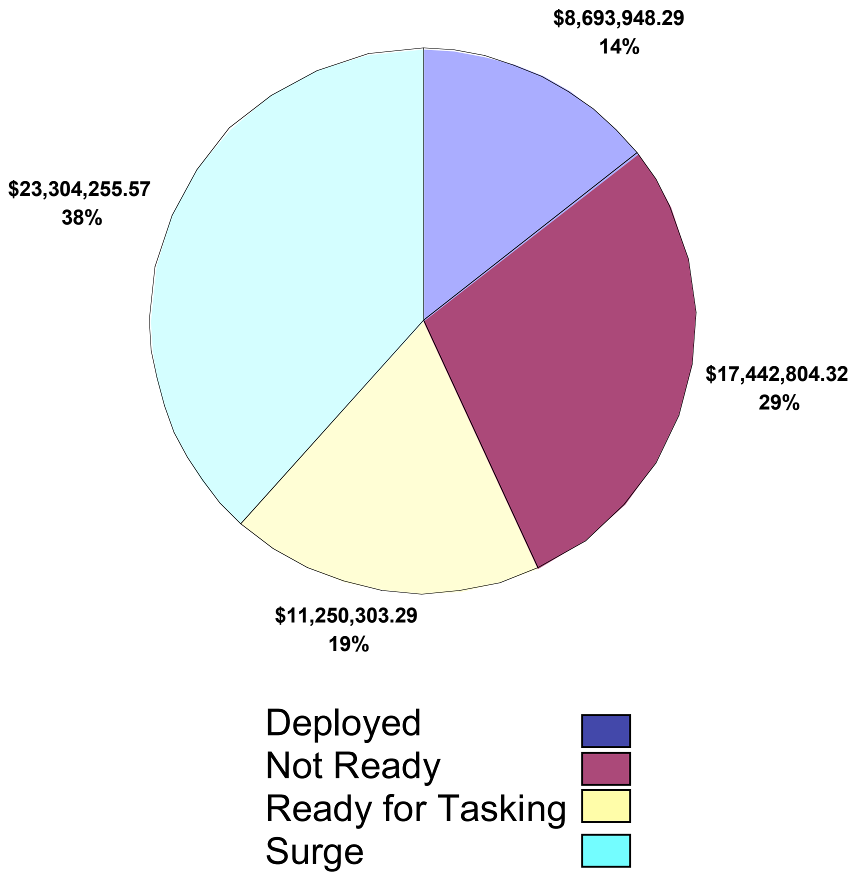

Figure 4

Figure 1 shows the percentage and total dollar net cost of 1B1B-SR spending isolated by FRTP phase. This graph was generated using Microsoft Access and the data set for all 11 submarines sampled.

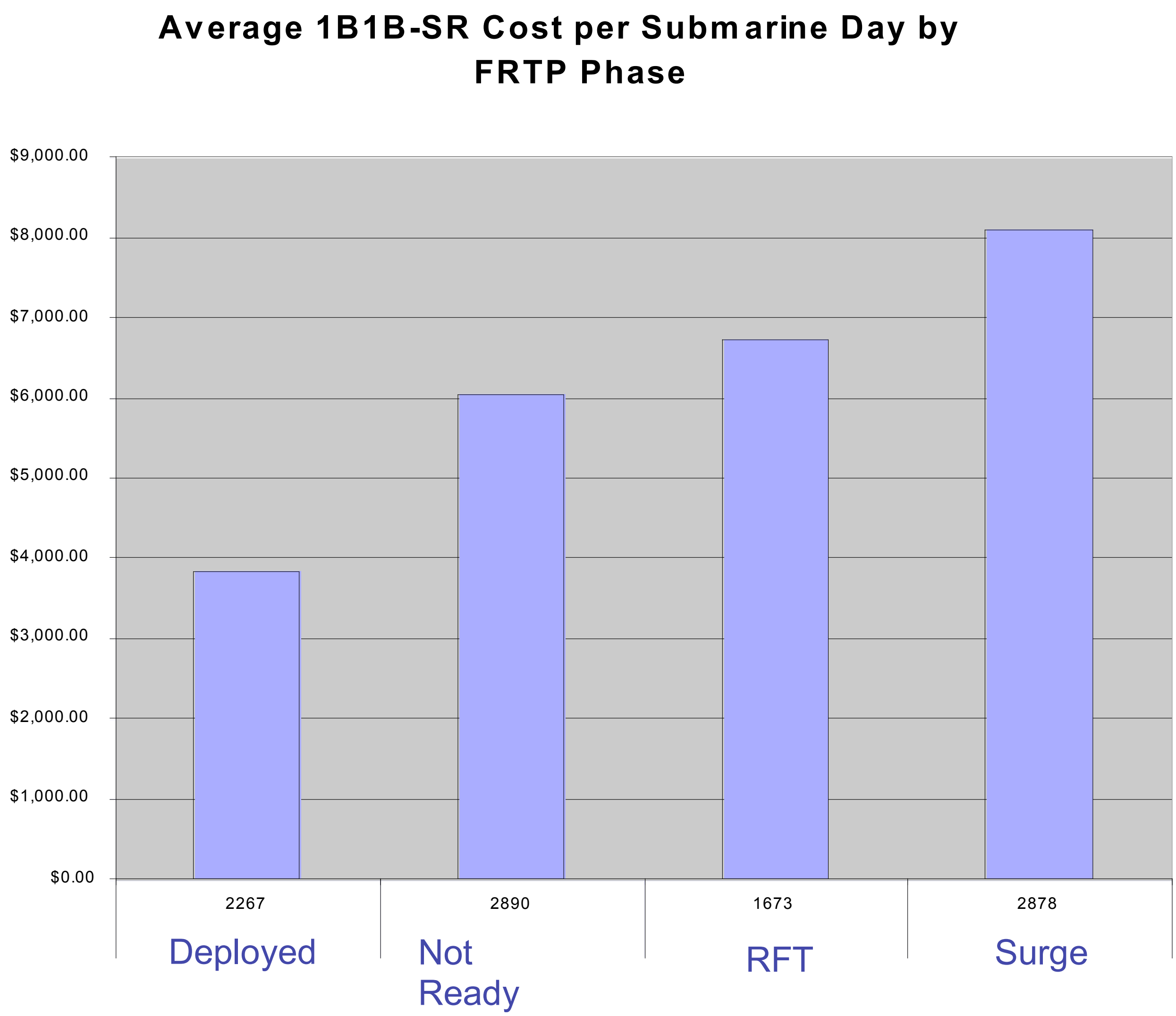

Figure 5

Figure 2 shows the average net cost per day of 1B1B-SR spending isolated by FRTP phase. This graph was generated using Microsoft Access and the data set for all 11 submarines sampled.

II. RECOMMENDATIONS

After a thorough analysis of the data and our conclusions, PGC recommends the following:

1. Ensure NSLC is provided with the data needed to distinguish between corrective and preventive maintenance. COMSUBFOR should coordinate with NSLC to ensure that COMSUBFOR units are submitting requisitions correctly, and conduct training with the Force to satisfy the NSLC requirements[1].

2. Conduct further analysis of the FRTP activities and phases in terms of frequency of cycling activities. This analysis may yield a strong relationship between start-ups, shut-downs, arrivals, and underways and corrective maintenance spending. If no relationship exists between the cycling of equipment and failure rate, this still provides useful data. Proving the absence of this relation allows the Force justification to continue cyclic operations if so desired.

3. The analysis of 1B1B-SR spending versus Mission Criticality Code provides the Force with the ability to evaluate the effect of deferring maintenance. However, before a decision is made to defer maintenance strictly based on MCC, on must recognize the risk of deferring maintenance on multiple

[1] According to Mr. Bill Casper at NSLC, PMS repair part requisitions should be submitted via SKED while corrective maintenance repair part requisitions should be submitted via OMMS-NG/R-SUPPLY. This ensures that the parts are properly coded for entry into OARS.

components within the same system and the compounded effect that may have on the ship's mobility or mission.

4. In order to make the predictive cost model as accurate as possible; COMSUBFOR should evaluate all data with as much detail as readily available and manageable. Specifically, we recommend that the FRTP be evaluated on a daily basis. Additionally, the ship's progression through the FRTP should be recorded in WEBSKED for historical accuracy.

5. The study performed by PGC has demonstrated the practical benefits of Microsoft Access for analyzing large databases. We highly encourage COMSUBFOR to maintain a staff professional who is an expert with Microsoft Access (or any similar database analysis tool). By incorporating other spending account records into a model like the one developed by PGC, COMSUBFOR can develop an incredibly detailed and powerful model. First, the Force must analyze the spending of the entire Fleet and calculate means and standard deviations of operational spending. This will allow the Force to employ standard statistical modeling tools, such as a Monte Carlo Simulation, to predict the ability of the Force to maintain a given level or readiness under various funding conditions. Similarly, the Force will be able to calculate the probability of achieving various levels of readiness for varying levels of funding. We highly encourage COMSUBFOR to use future EMBA project teams to complete these follow-on analyses and assist in building a reliable, predictive financial model for submarine readiness.

Events of the Submarine Force FRTP as defined by Peninsula Graduate Consultants:

A – Availability (not depot level, ship is still considered active in the FRTP)
C – COMPTUEX, JTFEX, GROUP SAIL, etc. . .
D – Deployed
I – In port, not in scheduled maintenance
M – Maintenance (smaller scale than A, defined above, predominantly ship's force)
N – Midshipmen Cruise
O – ORSE
P – POMCERT
R – TRE
S – SCC Ops
T – CODT and other at-sea training not specifically coded otherwise
V – INSURV
W – CSRR/TSRA
Z – INACTIVATION (used to describe the events of the USS Minneapolis-St. Paul at the end of her assignment in C2F, prior to her COHP)

Mission Criticality Codes as defined by NAVSEASYSCOM SCLSIS TECHSPEC

Code 1 – Failure of component/equipment causes minor impact on mission

Code 2 – Failure of component/equipment causes total loss/severe degradation of secondary mission

Code 3 – Failure of component/equipment causes severe degradation of primary mission

Code 4 – Failure of component/equipment causes total loss of mobility or severe degradation of mobility and primary mission

INITIAL DISTRIBUTION LIST

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   Norfolk, VA

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